REMARKS

Claims 1-30 were pending in the application. In the Office Action mailed December 7, 2009, claims 21-28 are withdrawn from consideration as directed to a non-elected invention, and claims 1-20, 29 and 30 are rejected. In the instant Amendment, claims 2, 14 and 29 have been cancelled without prejudice, claims 1, 13 and 30 have been amended, and new claim 31 has been added. Upon entry of the instant Amendment, claims 1, 3-13, 15-28 and 31 will be pending in the application.

Claim 1 has been amended to incorporate the contents of previous claim 2 and now recites that the concentration of uncompensated impurity is not more than $1 \times 10^{17}/cm^3$. Claim 1 has further been amended to recite an electrical resistivity at room temperature of 1.19×10^{10} Ωcm. Support for this amendment can be found in Table 1, bottom experiment, at page 20 of the filed specification.

Claim 13 has been amended to recite an electrical resistivity at room temperature of at least 1.19×10^{10} Ωcm. Support for this amendment can be found in Table 1, bottom experiment, at page 20 of the filed specification.

Claim 30 has been amended to recite an electrical resistivity at room temperature of not less than 4.74×10^{10} Ωcm. Support for this amendment can be found in Table 5, bottom experiment, at page 23 of the filed specification.

Support for new claim 31 can be found in Table 1, middle experiment, at page 20 of the filed specification.

No new matter has been added by these amendments. Entry of the foregoing amendment and consideration of the following remarks are respectfully requested.

Rejection under 35 U.S.C. § 112

Claims 13, 14, 29 and 30 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. Claims 14 and 29 have been cancelled without prejudice. Claims 13 and 30 have been amended to claim the specifically recited endpoints disclosed in Table 1, Example 1 at page 20 of the filed specification. Thus, the pending claims are properly supported by the disclosure and the rejection to claims 13 and 30 should be withdrawn.

Rejections under 35 U.S.C. § 102(b)/103(a)

Claims 1, 4-7, 11-14, and 29-30 are rejected under 35 U.S.C. § 102(b) as being anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as being unpatentable over Jenny et al., Deep Level Transient spectroscopic and Hall Effect Investigation of the position of The Vanadium Acceptor Level in 4H and 6H-SIC, Appl. Phys. Lett. 68:1963-1965 (1996) ("Jenny"). Claim 1 has been amended to incorporate the subject matter recited in claim 2. The rejections of the claims over Jenny are therefore moot.

Claims 1-18, 29 and 30 are rejected under 35 U.S.C. § 103(a) as being unpatentable over US 2001/0023945 to Carter et al. ("Carter").

Carter teaches semi-conducting silicon carbide without vanadium domination (Carter, title). Carter teaches that introduction of vanadium in silicon carbide crystal as a compensating element has certain disadvantages, such as negatively affecting the crystalline quality and reducing yield and adding production cost (Carter, page 2, paragraphs [0012]-[0013]). Carter discloses that its invention is characterized in that in its silicon carbide crystal, vanadium *is either absent, or if present, is present in amounts below those which will substantially affect the resistivity of the crystal* (carter, page 3, paragraph [0034]; emphasis added). In other words, Carter teaches that the presence of vanadium in any amount that may affect the resistivity of the crystal is undesirable. To render the crystal semi-conducting, Carter teaches increasing the number of intrinsic point defects in the crystal to be higher than the difference of donor and acceptor impurities (Carter, page 3, paragraph [0038]; page 5, paragraphs [0061]-[0063]) by irradiating silicon carbide with neutrons, high energy electrons, or gamma rays (Carter, page 5, paragraph [0067]). Carter teaches that the most preferable resistivity is merely at least 50,000 Ωcm at room temperature (see, Carter, page 3, paragraph [0036]). Thus, Carter does not teach or suggest utilizing vanadium in a silicon carbide crystal for high room temperature electrical resistivity. Carter does not teach or suggest controlling the amount of vanadium and the amount of uncompensated impurity in the silicon carbide such that the difference in concentrations of the uncompensated impurity and the vanadium is sufficiently low to achieve the high electrical resistivity.

In contrast, the presently claimed invention makes use of vanadium's capability to affect the resistivity to achieve electrical resistivity of 1.19×10^{10} Ωcm or more. As the application discloses, conventional high resistivity silicon carbide containing vanadium in a concentration higher than the uncompensated impurity suffers from problems such as low crystal quality and uneven resistivity due to uneven distribution of vanadium (the specification at page 5, line18 to page 6, line 5). Applicants have discovered that such problems can be solved by controlling the concentration of uncompensated impurity to within the recited range, and balancing the concentrations of the uncompensated impurity and the vanadium to achieve a sufficiently low difference in concentrations of the uncompensated impurity and the vanadium (the specification at page 11, lines 15-22). Applicants note that the requirement that the difference in concentrations of the uncompensated impurity and the vanadium indicates that the presently claimed silicon carbide must contain a sufficient amount of vanadium, which is contrary to Carter's teachings of minimizing the amount of vanadium. The application provides experimental data to show the importance of both controlling the concentration of uncompensated impurity and balancing the concentrations of the uncompensated impurity and the vanadium in achieving the claimed high resistivity (e.g., the specification at page 27, lines 16-26; and Table 7).

In the Office Action, the Examiner contends that Carter discloses a silicon carbide having ranges of concentrations for vanadium and uncompensated impurities overlapping those of the presently claimed invention, and that the present invention merely involves discovering and optimizing a workable ranges of Carter (Office Action at pages 5-6 and 10). However, as discussed above, Carter's silicon carbide crystals contain intrinsic point defects in an amount greater than the uncompensated impurity. The presently claimed silicon carbide, on the other hand, does not contain intrinsic point defects in such an amount, as evidenced by that the presently claimed silicon carbide contains sufficient amount vanadium, and by that the presently claimed silicon carbide is not subject to a process aimed at controlling the amount of point defects, e.g., irradiation with neutrons, high energy electrons, or gamma rays.

Additionally, Carter does not teach or suggest controlling the concentration of uncompensated impurity in its silicon carbide. In this regard, Applicants respectfully point out that Carter does not teach that the nitrogen impurity in its silicon carbide constitutes the uncompensated impurity. Instead, Carter expresses the amount of uncompensated impurities

as (N_d-N_a) or (N_a-N_d). Carter teaches that either the n-type or the p-type may predominate in accordance with an excess concentration of either n-type or the p-type dopants. See Carter, page 5, paragraphs [0061] and [0062]. Carter teaches "keeping the amounts of nitrogen or other dopants as low as possible, [so that] the number of point defects required to make the crystal semi-insulating can also be minimized" (Carter, page 3, paragraph [0038]). Thus, Carter's teaching of controlling the concentration of nitrogen does not teach or suggest controlling the concentration of uncompensated impurity.

Regarding routine optimization, as discussed in the previous response, only result-effective variables can be optimized:

> [a] particular parameter must first be recognized as a result-effective variable, i.e., a variable which achieves a recognized result, before the determination of the optimum or workable ranges of said variable might be characterized as routine experimentation.

MPEP 2144.05 II B at p. 2100-152 (Rev. 6, September 2007). In the present case, Carter did not recognize that electrical resistivity is a function of the difference in concentrations of the uncompensated impurity and vanadium. Thus, the parameter was not recognized by Carter to be a result-effective variable. In fact, Carter teaches optimizing the number of intrinsic point defects in the crystal to render the crystal semi-conducting, while the most preferable vanadium concentration being 1E14 (Carter, page 3, paragraphs [0037]-[0038]). In contrast, the present application shows that a vanadium concentration of less than 5.0×10^{14} Ωcm is not sufficient to achieve the claimed high resistivity in the presently claimed silicon carbide crystal. Therefore, a person skilled in the art would not have optimized Carter to control the difference in concentrations of the uncompensated impurity and the vanadium the difference as suggested by the Examiner. Instead, a person skilled in the art, following the teachings of Carter would have minimized the concentration of vanadium so that it does not affect the resistivity the silicon carbide, and increased the amount of intrinsic point defects to optimize the resistivity, which would have led to silicon carbide crystals that are different from that claimed in the present invention.

Thus, Carter does not teach or suggest the presently claimed invention. Claims 1-18, 29 and 30, are not obvious under 35 U.S.C. § 103(a) over Carter.

Claims 19-20 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Carter in view of US 6,522,080 to Faillon et al. ("Faillon").

US '080 teaches using SiC in microwave field effect transistors and is not concerned with vanadium or nitrogen doped SiC wafers. Therefore, since claim 1 is not obvious over Carter, claims 19-20, which indirectly depend on claim 1, are not obvious over Carter in view of Faillon.

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

KENYON & KENYON LLP

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By: Weining Wang

Weining Wang (Reg. No. 47,164)

KENYON & KENYON LLP
One Broadway
New York, NY 10004
(212) 425-7200

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